REMARKS

This paper is presented in response to the non-final official action dated August 14, 2008, wherein: (**a**) claims 1, 2, 4, 5, 7, 9-15, and 17-22 were pending; (**b**) claims 1, 2, 4, 5, 7, 9-15, and 17-22 were rejected under 35 USC § 103(a) as obvious over Medoff et al. U.S. Patent No. 6,207,729 ("Medoff") in view of Valenti et al. "Bulk Properties of Synthetic Polymer-Inorganic Salt Systems ...," *J. Phys. Chem.*, vol. 77, no. 3, p. 389-395 (1973) ("Valenti") and Polovina U.S. Patent No. 3,637,571 ("Polovina"); and (**c**) claims 1, 2, 4, 5, 7, 9-15, and 17-22 were rejected under 35 USC § 103(a) as obvious over Valenti in view of Medoff and Polovina.

Reconsideration and withdrawal of the rejections are respectfully requested in view of the following remarks.

I. Brief Summary of the Amendments to the Claims

Claim 1 has been amended to recite that the high melting temperature thermoplastic polymer is a nylon polymer, support for which may be found, for example, at ¶ 16 of the specification. Claim 4 has been canceled accordingly.

Claims 5 and 14 have been amended to recite that metal salt is added to the melted thermoplastic (nylon) polymer in the first extruder as a water solution comprising the metal salt, support for which may be found, for example, at ¶ 57-¶ 58 of the specification.

New dependent claim 30 has been added to recite particular metal chloride, bromide or iodide salts, support for which may be found, for example, at ¶ 22 of the specification.

New independent claim 31 is based on the combination of claims 1 and 5, but instead reciting a "metal halide salt" instead of a "metal chloride, bromide or iodide salt" and not requiring a particular amount of metal halide salt in the first mixture. Support for the amendments may be found, for example, at ¶ 14 (no particular metal salt amount required) and ¶ 58 (metal halide salt). New dependent claims 32-35 generally recite the same limitations already present in the pending claims.

By these amendments, there are four independent and 33 total claims (i.e., including multiple dependencies), which is fewer than the four independent and 39 total claims as originally filed. Accordingly, no additional claim fees are believed due; however, any additional fees may be charged to our deposit account 13-0610 under order number MSU 4.1-617.

II. The 35 USC § 103(a) Rejections Are Traversed

Claims 1, 2, 4-7, 9-15, and 17-22 were rejected as obvious (1) over Medoff in view of Valenti and Polovina and (2) over Valenti in view of Medoff and Polovina. *See* p. 2-12 of the action. The applicants traverse the obviousness rejections as set forth below.

A. Proper Basis for an Obviousness Rejection

The PTO bears the initial burden of presenting a *prima facie* case of obviousness. *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992); *see also* MPEP § 2142 (8th ed., rev. 6, September 2007). A *prima facie* case of obviousness requires that each and every limitation of the claim is described or suggested by the prior art, or would have been obvious based on the knowledge of those of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 1074 (Fed. Cir. 1988). Further, "rejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006). Thus, any analysis supporting an obviousness rejection should be made explicit and should "identify a reason that would have prompted a person of ordinary skill in the art to combine the elements" in the manner claimed. *KSR Int'l Co. v. Teleflex, Inc.*, 127 S.Ct. 1727, 1739 (2007).

Even though a conclusion of obviousness "is in a sense necessarily a reconstruction based on hindsight reasoning," MPEP § 2145(X)(A) (citing *In re McLaughlin*, 443 F.2d 1392, 1395 (CCPA 1971)), there are limits to its application. Specifically, hindsight reconstruction of a claimed invention *using the applicant's disclosure as a template* is impermissible and represents an insufficient basis to support a *prima facie* case of obviousness. The likelihood of impermissible hindsight increases along with the number and/or complexity of the claimed features asserted to be obvious. *See Ortho-McNeil Pharmaceutical, Inc. v. Mylan Laboratories, Inc.*, 520 F.3d 1358, 1364 (Fed. Cir. 2008) (explaining that "simply retrac[ing] the path of the inventor with hindsight, discount[ing] the number and complexity of alternatives ... is *always inappropriate* for an obviousness test" (emphasis added)).

For instance, "one cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention." *In re Fine*, 837 F.2d at 1075. Moreover, "a patent composed of several elements is not

proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *KSR Int'l Co. v. Teleflex, Inc.*, 127 S.Ct. at 1741. "Thus, where the invention sought to be patented resides in a combination of old elements, the proper inquiry is whether bringing them together was obvious and not, whether one of ordinary skill, having the invention before him, would find it obvious through hindsight to reconstruct the invention from elements of the prior art." *In re Warner*, 379 F.2d 1011, 1016 (CCPA 1967), *cert. denied*, 389 U.S. 1057 (1968).

B. Disclosure of the Applied References

Medoff is generally directed to texturized cellulosic (and lignocellulosic) materials and compositions using the same. Cut cellulosic material (e.g., flax, hemp) is sheared with a rotary cutter to form a texturized fibrous material generally having a length/diameter ratio of at least about 5. Medoff, 1:26-40, 3:20-37. The texturized fibrous material can be combined with a resin to form a strong, lightweight composite. *Id.*, 4:26-27. Polyamide is generically disclosed in a list of suitable resins, although all of the example composites are formed using high-density polyethylene (HDPE). *See id.*, 4:48-56 (listing different resins), 7:8-9:14 (Compositions 1-7 of Example 2). The composite can be formed and pelletized, for example using an extruder at less than about 190°C to both melt the resin and mix the blend of resin and texturized fibrous material. *Id.*, 5:50-58.

Valenti generally relates to mixtures of nylon-6 with one of a LiBr, LiCl, or KCl salt and the analysis of the melting behavior of the resulting mixtures. Valenti, abstract. The mixtures are prepared by wetting a nylon-6 polymer powder with a methanol solution of the salt in a glass tube. *Id.*, p. 390. The methanol is evaporated by holding the mixture at 50°C for 24 hr and then heating at 100°C for 5 hr under a vacuum. *Id.* The mixture of nylon-6 and metal salt is heated at 260°C for 5 hr or 72 hr to achieve fusion and optimum homogenization. *Id.*, p. 390 and 393. The mixture is then rapidly cooled to a temperature ranging from 100°C to 190°C for 48 hr or 220 hr. *Id.* A melting point depression was measured as a function of salt concentration. *Id.*, p. 392 and abstract.

Polovina is generally directed to a process for preparing thermoplastic resin-additive compositions. Polovina is cited for its teaching of a masterbatch process in

which additives are added to a polymer that is then pelletized in an intermediate step prior to molding. Office action, p. 3 and 10.

C. Presentation of a *Prima Facie* Case of Obviousness

Each of independent claims 1, 10, and 18 recites a thermoplastic polymer having a melting temperature of 200°C or above and a first mixture whose melting temperature has been lowered to less than 200°C by adding at least one of a particular metal halide salt to the thermoplastic polymer. The first mixture is then pelletized and extruded with temperature sensitive natural fibers to form a composite.

The action asserts that it would have been obvious to "incorporate the methods of Polovina and Valenti into that of Medoff" or, alternatively, to "incorporate the methods of Polovina and Medoff into that of Valenti." Office action, p. 3 and p. 11. The action essentially combines the references by using the nylon-salt mixture of Valenti as a resin matrix in the composite composition of Medoff. *See id.*, p. 4 and p. 11. Polovina is cited for the teaching of a masterbatch process used to form the intermediate material of Valenti into pellets prior to being used in Medoff's composite. *Id.*

Accordingly, the action effectively asserts that it would have been obvious to serially combine the processing steps of Valenti, Polovina, and Medoff to predictably yield the claimed process. However, this rationale for a *prima facie* case of obviousness still requires "a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." MPEP § 2143(A) (citing *KSR*). Absent such a reason, "this rationale cannot be used to support a conclusion that the claim would have been obvious to one of ordinary skill in the art." MPEP § 2143(A).

The applicants submit that the reasoning provided in support of the obviousness rejections is impermissibly based on hindsight, and is thus insufficient to establish a *prima facie* case of obviousness.

Specifically, none of the applied references addresses the problem of natural fiber degradation at temperatures above 200°C. While Medoff discloses fibrous cellulosic material reinforcements, it is silent with respect to fiber degradation. Further, Medoff teaches processing conditions that render the issue of fiber

degradation moot (e.g., an extrusion temperature of less than about 190°C and a preference for HDPE as the polymer matrix, which also has a melting point less than 190°C). Valenti and Polovina are silent with respect to fiber reinforcement in general, and they do not otherwise suggest the problem of natural fiber degradation. Thus, the action proposes a combination of references *to solve a problem that was not recognized in the applied references*. The addition of a metal halide salt to a nylon-based composite from Medoff would have appeared to the skilled artisan to be simply an unnecessary additional processing step and composition component that provided no perceptible benefit. Accordingly, absent impermissible hindsight, there would have been no reason that the skilled artisan would have combined the applied references to arrive at the recited processes. *KSR*, 127 S.Ct. at 1739; *In re Warner*, 379 F.2d at 1016.

Further, the action's only rationale linking Medoff and Valenti together is the assertion that Valenti provides a nylon-salt mixture that can be used as a matrix material for the composite of Medoff. Office action, p. 4 and p. 11. Given the broad range of possible matrix materials from Medoff, *see* Medoff, 4:47-53, the selection of particular material from Valenti represents the impermissible use of "hindsight reconstruction to pick and choose among isolated disclosures in the prior art." *In re Fine*, 837 F.2d at 1075. Such hindsight inappropriately "discounts the number and complexity of alternatives" present in the process of Medoff. *Ortho-McNeil*, 520 F.3d at 1364.

Accordingly, the action fails to support a *prima facie* case of obviousness with a reason prompting the skilled artisan to combine the references in the manner claimed, and the applicants request reconsideration and withdrawal of the obviousness rejections. *KSR*, 127 S.Ct. at 1739; MPEP § 2143(A).

D. Dependent Claims 5 and 14

Notwithstanding the foregoing, the applicants submit that dependent claims 5 and 14 recite further limitations that are not disclosed, taught, or suggested by the applied references.

Claims 5 and 14 recite that (i) the metal salt is added to the melted thermoplastic (nylon) polymer in the first extruder as a water solution comprising the metal salt and that (ii) the metal in the metal salt forms a reaction product with the

thermoplastic (nylon) polymer in the melt.[1] Thus, claims 5 and 14 more particularly define the manner of mixing and the result thereof in the extrusion melt-forming part (a) of parent claims 1 and 10, respectively.

Valenti is limited to the addition of a metal salt solution in methanol (i.e., not a water solution) to a nylon-6 polymer powder (i.e., not a melted polymer). Medoff and Polovina are silent with respect to the manner of adding a metal salt to a polymer, thus failing to remedy the deficiencies of Valenti in this regard. Accordingly, the applied references fail to disclose, teach, or suggest all recited limitations of the claims, and there can be no *prima facie* case of obviousness. *In re Fine*, 837 F.2d at 1074.

A polymer and metal salt can be suitably mixed in an organic solvent. Application specification, ¶ 56. However, such processes are generally time-consuming. *See* Section II.B above (Valenti's disclosed process of holding a mixture of polymer, methanol, and salt at a relatively low temperature for an extended period (i.e., 24 hr at 50°C) prior to melting the polymer and forming a homogenized polymer-salt mixture). Accordingly, these processes are not generally suitable for large-scale industrial applications. Application specification, ¶ 56.

The use of a water-metal salt solution provides a substantial advantage over the use of other solvents (e.g., methanol). Due to its higher boiling temperature (e.g., 100°C for water vs. 65°C for methanol) and heat of vaporization (e.g., 2300 kJ/kg for water vs. 1100 kJ/kg for methanol), the water tends to remain longer in the polymer-salt mixture when the metal salt solution is added to a hot polymer melt (i.e., 200°C or above) during extrusion. Prior to its evaporation, the water provides a liquid medium to facilitate (i) mixing with the polymer melt and (ii) formation of the metal-polymer reaction product as recited in the claims. In contrast, a lower-boiling solvent provides less residence time to promote mixing and polymer-salt reaction. In contrast to the short mixing times in the recited extrusion process, Valenti teaches that "the most critical factor in observing salt effects in the bulk state is an intimate homogenization of polymer and salt." Valenti, p. 394. Thus, practicing the proposed process based on the combined references would not have been expected to

[1] New claims 31-35 recite similar limitations and the following argument applies to claims 31-35 as well.

desirably result in a homogenous polymer-salt mixture having the recited reaction product.

Accordingly, the applicants submit that the foregoing represents an additional basis for the allowability of dependent claims 5 and 14.

E. Objective Evidence of Non-Obviousness

Notwithstanding the foregoing discussion regarding the lack of a *prima facie* case of obviousness, the applicants further submit that the pending claims are allowable on the basis of objective evidence of non-obviousness in the form of comparative data present in the application specification.

The application specification presents tensile and flexural properties for composites prepared according to the recited processes. The application examples were performed using a nylon-6 thermoplastic polymer, a variable amount of lithium chloride metal salt, and a variable amount of hemp natural fiber. Application specification, ¶ 86 (Table 4). The tensile and flexural properties of the resulting composites (and references corresponding to neat nylon-6 and nylon-6 with only a lithium chloride additive) are summarized in Table 1 below. In Table 1, the application specification data entries are labeled "Spec. 'n'", where "n" represents the n^{th} row entry of specification Table 4.

Table 1 also presents comparative data from a fiber-reinforced nylon-6 composite that omits the metal salt to establish the higher required melt temperature and the resulting fiber degradation. This is the comparison indicated as being relevant to the consideration of non-obviousness. Office action, p. 16.

Specifically, the data columns "Sears N" and "Sears G" are taken from Example 3 of Sears et al. U.S. Patent No. 6,270,883 ("Sears"). "Sears N" refers to a nylon-6 control sample, and "Sears G" refers to a composite of nylon-6 and 30 wt.% granulated RAYONIER-J cellulosic pulp fiber. *See* Sears, 15:50-52 (designated as "RAY-G" in the example). The nylon/fiber composite was extruded in a seven-zone extruder having a die temperature of 221°C and zone temperatures of 232°C, 218°C, 204°C, 107°C, 107°C, 107°C, and 107°C. *Id.*, 15:53-59. The nylon/fiber composite was then injection molded at 232°C and the mechanical properties of the resulting molded part were tested. *Id.*, 15:60-66, 16:8-20 (Table VII-A, dry property values for

the "Sears G" ("RAY-G") sample), and 17:22-32 (Table VIII-A, dry property values for the "Sears N" control sample).

The relevant data from the application specification and Sears were selected based on a similarity between their processing and testing conditions. Specifically, the application examples only included nylon-6, lithium chloride, and hemp fiber, and the resulting injection-molded coupons were tested for their mechanical properties without further conditioning. Thus, the "RAY-G" composition from Sears (which only included nylon-6 and fiber) was selected for comparison over the "RAY-P" composition from Sears (which included a binder and a softening agent in addition to nylon-6 and fiber). Similarly, Sears tested its composites both in a dry, "as-made" state and in a conditioned state (i.e., after storage at 72°F and 50% RH for 40 hr). The "dry" comparative data were selected for consistency with the testing conditions of the application examples.

Table 1. Comparative Mechanical Properties

	Spec. 1	Spec. 6	Spec. 7	Spec. 2	Spec. 4	Sears N	Sears G
Polymer	Nylon-6	Nylon-6	Nylon-6	Nylon-6	Nylon-6	Nylon-6	Nylon-6
Metal Salt (wt.%)	–	3.0	3.0	3.5	3.5	–	–
Fiber (wt.%)	–	–	30	–	30	–	30
Tensile Str. (MPa)	62.7	59.2	70.0 (1.18)	61.7	71.6 (1.16)	60.9	69.9 (1.15)
Tensile Mod. (GPa)	2.3	2.5	5.4 (2.16)	2.3	5.1 (2.22)	2.8	5.5 (1.96)
Flexural Str. (MPa)	84.5	91.7	120.7 (1.43)	98.8	128.4 (1.30)	66.0	80.6 (1.22)
Flexural Mod. (GPa)	2.2	2.4	5.8 (2.42)	2.8	6.5 (2.41)	3.0	4.3 (1.43)

In Table 1, the parenthetical values for the strengths and moduli represent the relative increase in a given mechanical property resulting from the inclusion of a fiber reinforcement. Specifically, "Spec. 4" and "Spec. 7" represent the increase relative to "Spec. 2" and "Spec. 4," respectively (i.e., based on the addition of 30 wt.% fiber to a nylon already containing a metal salt additive). For example, the tensile strength of "Spec. 7" is 18% higher than that of "Spec. 6." Similarly, "Sears G" represents the increase relative to "Sears N" (i.e., based on the addition of 30 wt.% fiber to a neat nylon).

From Table 1, it is apparent that composites prepared according to the recited processes have substantially improved mechanical properties compared to relevant prior art compositions. Specifically, the data illustrate the ability of the recited processes to reinforce a high-melting thermoplastic polymer with a temperature sensitive natural filler without degrading the fiber. Put another way, the benefit realized from the addition of a fiber reinforcement to a composite is substantially greater when the high-melting thermoplastic polymer matrix material (i.e., which has a first melting temperature of 200°C or above) additionally contains a sufficient amount of a metal halide salt (i.e., which reduces the melting temperature of the thermoplastic polymer to less than 200°C), as compared to the absence of the metal halide salt.

For example, comparing "Sears G" with "Spec. 4" and "Spec. 7" in Table 1, there is about a 20%-26% improvement in tensile modulus and about an 8%-21% improvement in flexural strength when the fiber reinforcement is added to a salt-containing polymer instead of a polymer absent the salt. The improvement in the flexural modulus is even more pronounced, being almost 100%. This significant improvement in certain mechanical properties can be attributed to the prevention of natural fiber degradation, as indicated in the application specification. Application specification, ¶ 9. Conversely, the composition of Sears must be extruded at temperatures above 200°C (i.e., to melt the nylon-6), and the natural fiber degradation resulting from the high extrusion temperature limits the improvement in mechanical properties resulting from fiber reinforcement.

The foregoing comparison of the data from the application specification with the data from Sears is relevant because the applicants may compare the claimed subject matter with prior art that is more closely related to the claims than the prior art relied upon in a rejection. *In re Holladay*, 584 F.2d 384 (CCPA 1978); MPEP § 716.02(e)(I). Moreover, the applicants need only compare the claimed subject matter with the closest prior art to rebut a *prima facie* case of obviousness. *In re Burckel*, 592 F.2d 1175 (CCPA 1979); MPEP § 716.02(e). The closest single prior art reference can be determined from "a comparison of the *claimed* invention with the disclosure of each cited reference to determine the number of claim limitations in common with each reference, bearing in mind the relative importance of particular limitations." *In re Merchant*, 575 F.2d 865, 868 (CCPA 1978) (emphasis in original).

In this case, the claims are directed to extrusion processes to reinforce a high-melting thermoplastic polymer with a temperature-sensitive natural filler without degrading the fiber (i.e., a thermoplastic polymer having a melting temperature above 200°C, the extrusion of which would degrade the natural filler without a metal salt polymer additive). Thus, an analysis of the closest single prior art reference takes into account the relative importance of these limitations. Accordingly, it is proper to compare the recited processes with Sears as set forth in Table 1, because Sears involves the extrusion of a nylon-6/cellulose fiber composite (i.e., a high-melting thermoplastic polymer and a temperature-sensitive fiber). Conversely, the examples of Medoff are less relevant, because they are limited to HDPE, a thermoplastic polymer having a melting temperature below 200°C. Similarly, Valenti is only remotely related to the recited processes, inasmuch as it has no relation to any sort of reinforcement (natural fiber or otherwise) or an extrusion process.

Thus, although the action asserts that "the issue [of objective evidence of non-obviousness] includes, at least in part, analysis of whether reinforcement would have been expected to improve the strength of the Valenti," office action, p. 16, the applicants submit that a comparison with Valenti is neither relevant nor necessary. It is irrelevant that one of the current rejections is based on Medoff as the base reference and the other rejection is based on Valenti as the base reference. The recited processes need only be compared with the closest prior art. Valenti, however, merely stands for the teaching that certain metal halide salts can depress the melting temperature of a nylon polymer and is completely unrelated to the temperature sensitive natural filler-reinforced thermoplastic polymer compositions that form the focus of the recited processes. Thus, Valenti is only tangentially related to the recited processes, and, accordingly, Valenti is not the proper basis for evaluating objective evidence of non-obviousness.

Accordingly, the foregoing data and comparisons illustrate that the recited methods provide the unexpected and substantial benefits of being able to combine a high-melting temperature thermoplastic polymer that has favorable base mechanical properties with an inexpensive, temperature-sensitive natural filler reinforcement while still being able to obtain the strength improvements of a filler-reinforced composite. Thus, the resulting composite can be produced at a reduced cost in combination with improvements in strength, recyclability, etc. Application specification, ¶ 6.

The applicants submit that the foregoing represents a sufficient demonstration of unexpected results for the pending claims. Further, the weight of the objective evidence applies with even more force to claim 1, which specifically recites a thermoplastic nylon polymer. Accordingly, the applicants request reconsideration and withdrawal of the obviousness rejection on this additional basis.

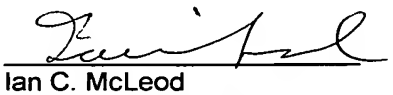
F. Allowability of New Claims 30-35

The applicants submit that new claims 30-35 are allowable for at least the reasons provided above in Sections II.C to II.E above.

CONCLUSION

In view of the foregoing, entry of the amendments to claims 1, 5, and 14, cancellation of claim 4, entry of new claims 30-35, reconsideration and withdrawal of the rejections, and allowance of all pending claims are respectfully requested.

Respectfully,



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